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THE PROBLEM OF THE HISTORY OF SCIENCE IN THE COLLEGE CURRICULUM*

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IF one were asked to describe in a single phrase the present-day position of the history of science in the college curriculum, I think he might fairly call it the "Ugly Duckling" of the program. For while it is just now receiving the treatment of an orphan, and the department of history has never seen fit to take this fledgling under its wing, the young bird has perhaps nevertheless all the possibilities of becoming a swan.

I hope to make my meaning clearer by saying a few words about the place for such a course, about the character of the course, and finally about the man for the course. In fact, I wish to offer a brief plea for a more human treatment of the fundamental sciences than they are now receiving, and I want to suggest that the most effective method of accomplishing this result is the introduction of courses on the history of science.

1. *First,* as one glances down the average college curriculum, and the faculty list, he may, I think, fairly admit that political and social history are well handled by men who are competent specialists—the men, indeed, who constitute the membership of your association.

Of the history of English literature the same may be said.

In the case of foreign literature, it is only after the student has passed beyond the technique required for easy reading, that he is introduced to the historical development of either the language or the literature. Economics, philosophy and psychology are frequently, at least, presented in the order of their chronological development, *i. e.*, in the historical order in which the facts were discovered—the order which Darwin has taught us is the natural order.

The modern college offers to its students practically only four lines of training—four topics which one might call "the modern quadrivium." These are

(i) Languages and literature.
(ii) Historico-political study and economics.

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(iii) The Philosopical group, including psychology, education, religion, logic, and mathematics.
(iv) The experimental and observational sciences; or, if you prefer, the physical and natural sciences.

Of these four topics, it is only the last mentioned which is *not* already receiving a more or less distinctly historical treatment. The typical natural sciences are, I suppose, *Zoology* and *Botany;* the corresponding physical sciences are *Physics* and *Chemistry.* These four sciences constitute the foundation upon which the other sciences rest; or, if any one prefers, they are the sciences which are in an especial way ancillary to all the others.

Physiology, hygiene, bacteriology, medicine, etc., naturally develop from biology, just as astronomy, geology and engineering come from physics and chemistry. Each of these four fundamental sciences does, of course, receive historical treatment in numerous curricula; but in many institutions no such course is offered. Professor W. F. Magie has published a complete treatment of physics written from the historical point of view. It might be called historical physics rather than a history of physics; since the emphasis is rather upon the clear and careful statement of the principles of the science, than upon its history. A combined course on the natural and physical sciences is offered by Professors Sedgwick and Tyler. My colleague, Professor Locy, has for many years given a very successful course on the history of biology. Numerous courses in the history of chemistry are given: more than twice as many as are given upon any other of the four fundamental sciences. Some are also offered in the general history of science, such as those by Professor L. J. Henderson, of Harvard, by Professor Walter Libby, of Pittsburgh, and by Dr. George Sarton.

The need for courses in the history of science appears to lie rather in these four fundamental sciences than in any subject outside: this, partly because the early history of these four subjects covers practically all the other sciences, and partly because the history of science, in general, appears to be quite too large a topic for one man to treat intelligently and sympathetically.

The theorem then which I propose is the following: Every college of liberal arts owes it to itself and to its students to offer at its earliest opportunity courses in the history of botany, zoology, chemistry and physics, in addition to the numerous historical courses already offered in other branches of the modern quadrivium.

2. Passing now to the character of the course which should be presented, this is, manifestly, always a question of time, place and man. Nevertheless, there are certain considerations which have, I believe, a wide validity among American colleges.

It was my privilege a few weeks ago to attend a lecture on *general physics* given by a young man who was offering the course for the first time. I was present on invitation and the comments which I am now about to make are precisely those which I gave to the young man himself at the close of his lecture.

The discourse was well illustrated by experiments; his demonstrations were clever and orderly; his explanations were clear and correct. He was evidently master of his subject, which on this particular morning happened to be *elasticity*.

But Hooke's Law was demonstrated without the slightest reference to that crabbed and crusty, but tremendously clever old bachelor, Robert Hooke, who lived in Gresham College and entertained the Royal Society of London so frequently and faithfully with the latest scientific results obtained sometimes by his own labors, sometimes from the labor of others.

This young instructor next proceeded to define Young's modulus and to derive the algebraic formula for it, without so much as a mention of that brilliant London physician, who at the beginning of the nineteenth century was perhaps the most variously accomplished man of science in England, the young Quaker, who as a medical student at Göttingen found ample time, between the more serious duties of a strenuous program, for lessons in dancing and horseback riding.

The elasticity of air was next expounded under the caption of Boyle's law, without any one of the one hundred and fifty auditors suspecting the existence of that charming old Irish bachelor, who largely held together and inspired the "Invisible College" out of which the Royal Society grew; the author of the "Skeptical Chymist"; "Robyn," as his sister called him; the intimate friend of Evelyn, Pepys, and Newton; director of the East India Company.

One can imagine that in his succeeding lecture my young friend would deduce and demonstrate with precision and elegance, the laws of collision, while his students are kept completely in the dark as to the three remarkable men—men of the first order—Huygens, Wallis and Wren—who first established these laws.

This bit of experience is mentioned, not in criticism of this young man, of whom I am an ardent admirer and to whom I have already said all I am saying to you, but rather to raise this question: Is science in America to be forever presented as a set of abstract principles, a set of generalizations, derived, it may be, in the first instance, from experiment or observation, but now formulated in the most impersonal way possible? Or is science to be treated as a distinctly human achievement?

Are not experimental results simply the facts which human beings have deciphered from the scroll of nature? Are the laws of physics and chemistry anything more than human expressions, adapted to finite human capacities, and accepted because of their convenience in human conversation? Is a theory in astronomy anything more than the "present policy"—to use Sir J. J. Thomson's phrase—proposed by some human observer for convenience in making prediction for later human observers? Are the bodies of plants and animals anything more to the student of biology than the source-books from which some human investigator has unraveled the laws of development and hygiene—the laws of birth, growth, death and disease? Do the various extensions of physical and natural laws to include new observations mean anything more than the fact that present investigators stand upon the shoulders of their fathers and thus acquire a wider and deeper vision?

If now this edifice which we call modern science—this body of "impersonally verified truth"—borrowing Professor Minot's excellent phrase—is an incomplete human structure, if it is after all merely a record of human thought, a formulation by the human mind, tremendously useful to the physician in the prevention and cure of human disease, valuable to the engineer in securing human comfort and safety, and human leisure for other forms of human activity; if, I say, science has all these human elements in it, why may it not be so presented to the student?

Let us, of course, concede that Dante's *Comedia,* with its human inferno, filled with striking pictures of all human qualities, the frail and the strong, the good as well as the bad, is a rare and powerful stroke of the human imagination. But what shall we say of the investigations of Copernicus and Kepler and Aristarchus, reaching out into vast space and finding unheard of orbits, speeds and distances?

Let us concede that Homer's story of Achilles going out after Hector is one of intense human interest. But what shall we say of the fight which Galileo maintained from boyhood to death, in such a skillful manner as to allow him, meanwhile, to accomplish his two great works and get them through the press?

Let us concede the lofty flight of the human imagination in which Milton casts Satan out of heaven. But what shall we say of the many superstitions cast out of the human mind by Milton's contemporaries—Huygens, Newton, Pascal, Harvey and Leeuwenhoek?

We are all glad to recognize the rare and human beauty of Tennyson's verse; but let no one imagine that he is either nodding or stepping down when he sings the story of evolution. Is the exquisite flight of genius in which his contemporary, Clerk-Maxwell, describes the essential features of that wonderful human convenience called wireless telegraphy, a quarter of a century before the art was realized in experiment, any less appealing?

Now having made all these concessions and as many similar ones as you like, does there not remain sufficient human interest in science to justify its presentation as a human achievement, rather than a heartless, bloodless, colorless, body of cold rigid fact? Tragedy and comedy, pathos and humor are, of course, never found in nature. We must seek them in human nature; the history of science is full of them. "The fairy tales of science and the long results of time" with which Tennyson nourished his "youth sublime," offer as large a field for the imagination as any other theme of poetry; the one difference lies in the fact that the scientific imagination must be bridled by reason; but this curbing of the imagination by reason is all that we mean by clear thinking; and clear thinking is the goal of all our work.

Now, I have not even mentioned the "humanities." I shy at the term, only because I fear it has come, in many quarters, to mean almost the exact opposite of the spirit which prompted the composers of Greek and Roman literature, and also the opposite of that which was intended by the men who introduced the term in the fifteenth century. Nevertheless, I trust, I have fairly indicated the possibility and desirability of treating science in a humanitarian manner and of making it one of the real humanities of the modern curriculum. If accuracy of judgment and clearness of thought are to be sought in the new quadrivium, they will be found most easily and most frequently through the study of language and science. It is especially up to those of us who teach the history of science to present its human aspects—which are not for a moment to be identified with its merely practical and commercial aspects—and thus redeem the word "humanity" from the narrow sense in which it is employed at Oxford and in the Scottish universities.

3. Let us now pass to the man who ought to offer such a course; that is, a course which shall present science as an evolution of the human mind—as a growth rather than as a finished product. There is a helpful French proverb to the effect that "at thirty every man is either his own physician or a fool," suggesting that at an earlier age he is too busy with other matters to care much about his own health. It is somewhat so with the young man who has just made his doctor's thesis in science. He is so much absorbed in the beautiful unity which he has recently discovered in his subject, and so eager to get a still wider and firmer grasp of his specialty that he finds little time to spend upon its developmental history.

With the recently appointed assistant professor, the circumstances are not very different. He also has little time for the past. "Dead men ride fast horses." He is too busy with his own research along his chosen line. He can not leave it except for the perfunctory teaching of those courses which, in common decency, he must offer. If one sugests to him the possibility of his offering a course in the history of his topic, his reply resembles a stanza in which Mr. Kipling once declined an invitation to dinner from the boys at Yale.

> When you grow older, and skin your shoulder
> At the world's great wheel in your chosen line,
> You'll find your chances, as time advances,
> Of taking a lark are as slim as mine.

This was indeed my own view for many years. Time spent on the history of physics was time spent on a luxurious lark. "The years go fast at Oxford."

The full professor is not far from forty years of age. With him the circumstances have begun to be a little different. The connection of his own work with that of others is more evident. The philosophy of the subject is interesting him more and more. He is now aware of the fact that the lives of the founders of the Royal Society are inseparable from the civil wars of England, the great fire and the great plague of London; that Darwin and Kelvin are just as essentially features of the Victorian era as are Gladstone and Tennyson; that Pascal and Torricelli and the Accademia del Cimento are inseparable from the religious history of their times—the age when science was supported, if at all, by royal patronage. "Knowledge comes, but wisdom lingers." Here then is the man who ought to teach the history of science. One who is familiar with the technique of investigation. One who knows the mode of thought employed in research. One who is willing to take the pains and pay the price of making some small contribution to human knowledge: one who is able to bend the English language to his own purpose.

This man will be too keenly aware of his limitations to undertake the history of *all* the sciences, and will find the available hours brief enough for a history of his own science. An illuminating confession along this line is the public address given by the distinguished editor of the *Review* when, overwhelmed with the rapid development of mathematics, he broke off in the midst of a brilliant university career to take up newspaper work. A similar confession came to me a few weeks ago from a man who had left his favorite field for ten years of executive work, only to find on returning to the field that the landscape was covered with a new and entirely unfamiliar growth.

The outstanding difficulty in the way of any man of science giving a historical course is that scholar's instinct which tells him that, as a rule, he lacks the proper historical background, and does not have the easy confidence of the man who has been long in training at general history. Nevertheless, if we can find men of breadth and vision, men of at least forty years of age, who are willing to present the developmental histories of the fundamental sciences, especially physics, chemistry and biology, and to present them in such a way that they will furnish the student with a generous culture, and put him *en rapport* with his environment, the place of our subject in the college curriculum will soon be established.

Nor is the proposition one which we need fear to urge upon our university presidents, our colleagues or our students; for just as water is the great, common and dominating feature of the globe, so is science the one common feature of all nationalities and all civilizations. Science does not differ from nation to nation as do language, religion and politics. The history of science is therefore something almost as wide as the human race and deserving of humanitarian treatment.